AD693260

Technical Research Note 211

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EFFECTS OF INFORMATION REQUIREMENTS, TIMING PROCEDURES, AND PHOTO SCALE ON INTERPRETER PERFORMANCE

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SEP 15 1969

BESRL

U. S. Army
Behavioral Science Research Laboratory

July 1969

28

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July 1969

Army Project Number
2Q662704A721

Interpreter Techniques a-12

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FOREWORD

The SURVEILLANCE SYSTEMS research program of the U. S. Army Behavioral Science Research Laboratory has as its objective the production of scientific data bearing on the extraction of information from surveillance displays, and the efficient storage, retrieval, and transmission of this information within an advanced computerized image interpretation facility. Research results are used in future systems design and in the development of enhanced techniques for all phases of the interpretation process. Research is conducted under Army RDT&E Project No. 2Q662704A721 "Surveillance Systems: Ground Surveillance and Target Acquisition Interpreter Techniques," FY 1969 Work Program.

The BESRL Work Unit, "Determination of Interpreter Techniques in a Surveillance Facility," conducts research to develop quick-time screening and interpretation methods that will enable an interpretation facility to process rapidly the vastly increased amounts and different kinds of imagery expected through advanced techniques for acquiring aerial imagery. The present publication reports on experimentation in the rapid screening of (real-time) imagery under differing conditions of intelligence requirements, timing, and photo scale.

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EFFECTS OF INFORMATION REQUIREMENTS, TIMING PROCEDURES, AND PHOTO SCALE ON INTERPRETER PERFORMANCE

BRIEF

Requirement:

To determine how the screening of real-time imagery for frames containing priority targets and the immediate identification of targets are affected by variations in the complexity of the task, timing procedures, and photo scale.

Procedure:

School-trained image interpreters (N = 32) screened imagery to select frames containing priority targets, at the same time detecting and identifying the targets. Half the interpreters were to identify priority targets exclusively; the other half were to identify priority targets and also to annotate any non-priority military objects detected while searching for priority targets. Another division of the interpreter sample was made for photo scale, half working with imagery at 1:3,300, half with imagery at 1:2,200. Half were mechanically paced through the missions, half paced themselves under a total time limit. Experimental conditions were allotted according to a 2^3 factorial research design. Performance on both screening and target identification was evaluated for completeness and accuracy.

Findings:

Interpreters searching exclusively for priority targets achieved more complete selection of priority target frames and priority target identification but were less accurate in both aspects of the task than those providing additional annotations.

Interpreters mechanically paced through the missions were less accurate, but no less complete in identifying priority targets than those under a total time limit. In screening, timing procedures produced no significant differences.

Scale variation had no effect on the completeness or accuracy with which interpreters selected target frames or identified priority targets.

Interpreters required to annotate objects other than priority targets (the "priority plus" requirement) annotated on the average 37 percent of the non-priority targets in the time allotted. Identifications were 83 percent correct.

Utilization of Findings:

For the conditions typified by this study, photo scales in excess of 1:3,300 produce no significant improvement of interpreter performance.

It appears that interpretation facility chiefs can control the completeness or accuracy of performance of interpreters by varying the structure of the task imposed. In "hot reporting" for priority targets, the interpreter assigned the "priority only" requirement will be more complete while the assignment of the "priority plus" requirement will result in lowered completeness but fewer erroneous responses.

EFFECTS OF INFORMATION REQUIREMENTS, TIMING PROCEDURES, AND PHOTO SCALE ON INTERPRETER PERFORMANCE

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EFFECTS OF INFORMATION REQUIREMENTS, TIMING PROCEDURES, AND PHOTO SCALE ON INTERPRETER PERFORMANCE

There is frequent need for immediate information concerning the presence or absence, location or disposition, and number of certain high threat enemy elements in a given area. Specific information about priority targets is extracted from an aerial reconnaissance mission and forwarded from the interpretation facility in a Hot Report. In generating such a report, the image interpreter rapidly scans the imagery, seeking to detect and identify the required priority targets within the time allotted. His report must be made within a relatively short period of time to insure its maximum usefulness. Obviously, the report must be as complete and as accurate as possible in order to provide the commander with the relevant information upon which to base an intelligent and appropriate plan of action.

As the interpreter goes through the imagery searching for priority targets, he often detects and identifies, to some level of exactness, enemy positions and pieces of materiel that are non-priority objects under immediate intelligence requirements. These he may pass over without making any record of his observations. At some future time, another interpreter--or perhaps the same one who made the Hot Report on the mission--will be required to go over the same imagery making a detailed report. It appears desirable to design a technique for recording these potentially useful identifications so as to preserve any information extracted by the image interpreter during his search for priority objects.

OBJECTIVES OF THE RESEARCH

The general purpose of this present study was to explore the effect of changing selected aspects of the work situation on the performance of the image interpreter. Three specific objectives were established:

1. The central objective was to determine the extent to which, in the screening process, peripheral information--non-priority information at the moment--might be preserved for future use. If non-priority objects could be annotated or recorded in some fashion requiring but little added time, the time required for the preparation of more detailed reports produced subsequent to the initial "hot report" might be reduced.

2. A second objective was to determine how timing procedures--one aspect of work method--imposed on the interpreter affects his performance. Normally, the interpreter is under time pressure in preparing a Hot Report and must pace himself so as to complete the task within the allotted time. If he spends too much time on the early portion of a mission, he may be unable to complete the entire mission. An alternative method by which the interpreter was mechanically paced through the imagery so as to complete the task within the allotted time was devised. It was hypothesized that, by freeing the interpreter from the need to pace himself and thereby allowing him to concentrate wholly on the detection and identification task, his performance would be improved.

3. The final objective was to determine how interpreter performance in the detection and identification of priority objects varies as a function of photo scale. Photographic imagery in which the same terrain appeared at two different scales was available and was used to examine the possibility that even a relatively small change in scale might produce a significant change in interpreter performance during the preparation of a Hot Report. The study was not intended as exhaustive, since scale has been included in other studies.

METHOD

Research Design

The experimental design was a 2^3 factorial, the independent variables being interpretation requirement, timing procedure, and photo scale, each at two levels. The two interpretation requirements differed in complexity. In one case, interpreters limited their search to priority targets. In the other, they annotated any other objects of potential military interest they noted while screening the imagery for priority information. Instructions for the two requirements appear below:

<u>"Priority Only" Requirement</u>

1. Mark the location of all tanks, APC's, and SP guns directly on the film.
2. Number locations serially, beginning with one for each target frame.
3. Report each identification in the answer booklet opposite the number you assigned that object.

<u>"Priority Plus" Requirement</u>

1. Mark the location of all tanks, APC's, and SP guns directly on the film.
2. Number locations serially, beginning with one for each target frame.
3. Report each identification in the answer booklet opposite the number you assigned that object.
4. Annotate, on the film, the location of wheeled vehicles, tents, and other military objects noted; <u>DO NOT SPECIFICALLY SEARCH FOR SUCH OBJECTS</u>.

Under one timing procedure, the interpreter was given 25 minutes to detect and identify the priority targets shown on a 50-frame roll of film. He had to pace himself so as to complete the task within the allotted time. A second method also allowed the interpreter 25 minutes to complete his tasks, but he was provided with a counter which pulsed every 30 seconds, displaying at intervals a number indicating the frame the interpreter should be viewing at a given time. Each frame was numbered, and the interpreter was to pace himself by the counter.

Finally, photo scale was controlled so that the imagery used presented the same ground area at two different scales--1:3300 and 1:2200.

Performance was measured in terms of the accuracy and completeness with which photo frames containing one or more of the priority targets were sorted out from the rolls of film and the priority targets detected and identified. Where interpreters were to annotate the imagery with respect to non-priority military objects, in addition to priority targets, completeness and accuracy for non-priority military objects were assessed.

Experimental Materials

Imagery. The performance measures used to evaluate the effects of the treatment variables were based on four 50-frame rolls of positive transparencies. The imagery covers various portions of terrain around and including Camp Drum, New York. Each roll differs from the others in coverage and target distribution.[1] Multiple copies of each of the four basic rolls were available. Of the 200 frames in the four rolls, 37 contained priority targets--tanks, Army personnel carriers, self-propelled guns, or some combination of these. Table 1 gives details of the imagery used.

Equipment. Each of 16 work stations was equipped with a light table on which the film rolls could be mounted so that the interpreter could search the frames of each roll successively. Eight of the stations were furnished with digital readout displays that could be activated by a central timer set to emit a pulse every 30 seconds. Each interpreter was given the roll of film he was to screen, pencils, and an answer booklet in which to record the identifications he made. Each man was also given a numbered grid to be used in designating the location of the targets or objects identified.

Sample

Sixteen officers and sixteen enlisted trainees comprised the experimental sample. These men and officers took part in the experiment just prior to their graduation from the Image Interpretation Course of the United States Army Intelligence School at Fort Holabird, Maryland. The enlisted trainees were the first group to participate in the experiment. They were randomly assigned to the eight treatment conditions, two men to a cell. One week later the officer trainees were given the same tasks to perform. The sixteen officers also were randomly assigned to treatment conditions with two officers in each cell. Each of the two experimental sessions required one full school day.

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[1] The rolls of imagery were selected from those in the Image Interpretation Film Library maintained by the Technical Services Branch of the Support Systems Research Branch, BESRL.

Table 1

IMAGERY CHARACTERISTICS AND TARGET CONTENT OF PERFORMANCE MEASURES

Imagery Characteristic or Target Content	Roll Designation[a]								Sum
	T-45	T-46	T-47	T-48	T-49	T-50	T-51	T-52	
Photo Scale and Frame Format									
1:3,300, 6x6" format	x	....	x	....	x	....	x	....	...
1:2,200, 9x9" format	....	x	....	x	....	x	....	x	...
Code Designation of Area Covered in Roll	A	A	B	B	C	C	D	D	...
Frames									
No. with only[b] Priority Targets	4		4		3		[illegible]		14
No. with only Non-Priority Targets	11		10		11		11		43
No. with both Priority and Non-Priority Targets	5		7		5		6		23
No. of Non-Target	30		29		31		30		120
Total Frames per Roll	50		50		50		50		200
Targets									
Priority:									
Tanks	29		23		14		25		91
APC's	0		2		2		2		6
SP Guns	1		4		7		0		12
Total Priority	30		29		23		27		109
Non-Priority:									
Wheeled Vehicles	54		47		46		58		205
Tents	16		12		14		19		61
Other	4		1		1		8		14
Total Non-Priority	74		60		61		85		280
Total No. of Targets	104		89		84		112		389

[a]Pairs depicting the same ground area at different scales are T-45 and T-46, T-47 and T-48, and T-49 and T-50, T-51 and T-52.

[b]Below this point, a single value is given to describe the target content of the two rolls covering the same area.

Conduct of the Experiment

Practice Session. Interpreters were given detailed preliminary instructions that included a description of the purpose of the experiment, the nature of the task, and method of recording responses. Eight of the 16 in each group were instructed in the purpose and use of the pacing equipment. Each interpreter screened a practice roll of 25 frames. The experimenter resolved any questions raised and assured himself that each man understood what he was to do.

The Experiment Proper. Each interpreter screened four 50-frame rolls of photographic transparencies. Rolls of film were counterbalanced so that, over the 32 interpreters, each roll was viewed first, second, third, and fourth an equal number of times to control for possible biasing order effects. The research design is shown in Figure 1.

		Work Method	
Interpretation Task	Photo Scale	Self Paced	Machine Paced
Priority Only	Small Scale	2 Officers 2 Enlisted Men	2 Officers 2 Enlisted Men
	Large Scale	2 Officers 2 Enlisted Men	2 Officers 2 Enlisted Men
Priority Plus	Small Scale	2 Officers 2 Enlisted Men	2 Officers 2 Enlisted Men
	Large Scale	2 Officers 2 Enlisted Men	2 Officers 2 Enlisted Men

Figure 1. Experimental Design of the Study

For the priority-targets-only condition, the interpreter searched for, identified, and annotated directly on the film the priority targets specified (tanks, APC's, and SP guns), at the same time classifying each frame as a target or non-target frame. The recording was done as follows for each frame: As he identified each target, he marked each item and numbered each marking to show whether the target identified was the first, second, or n^{th} target he had identified on that frame. Numbering began anew with each frame. After annotating the location of each target on

the film, the interpreter recorded in his answer booklet the identification of the object and the number he had assigned to it. He continued in this manner until he had detected and identified all priority targets on the frame and then went on to the next until he had analyzed all 50 frames or until 25 minutes had elapsed. The interpreter working under the priority-plus condition followed the same procedure. However, if he detected a non-priority object, he annotated the film by 1) circling any object seen as a wheeled vehicle, 2) drawing a triangle around any object seen as a tent, 3) making a check mark beside any non-identifiable military object. These identifications were recorded in the answer booklet along with those of priority targets. Classification of a frame as a target frame was inferred from the identification of a target within the frame as a priority target.

Upon completion of the task--or at the end of 25 minutes--each interpreter went back to the beginning of the roll and recorded the grid location of each target or object he had annotated, using the numbered grid furnished. The grid locations were used for scoring purposes only.

For interpreters working under the pacing procedure, there was no requirement that they work on a given frame until the number of the next frame appeared. They were, however, cautioned against falling too far behind.

Dependent Variables

<u>Screening Performance</u>

Accuracy:	Ratio of number of frames correctly reported to contain priority targets to the total number of frames reported to contain priority targets (correct + incorrect).
Completeness:	Ratio of number of frames correctly reported to contain priority targets to the total number of frames actually containing priority targets (37).

<u>Target Identification</u>

Accuracy (priority targets):	Ratio of number of priority targets correctly identified to total number of priority identifications made (correct + incorrect).
Completeness (priority targets):	Ratio of number of priority targets correctly identified to the total number of priority targets contained in the imagery (109).

Accuracy (non-priority objects):	Ratio of number of non-priority military objects correctly identified to total number of non-priority objects identified (correct + incorrect).
Completeness (non-priority objects):	Ratio of number of non-priority military objects correctly identified to total number of non-priority objects contained in imagery (280).

Analysis of Variance

For both screening and priority target identification, completeness and accuracy scores on task requirements of two degrees of complexity, under two timing procedures, and on imagery of two scales were subjected to a three-way analysis of variance. Treatment effects associated with statistically significant results are indicated in the summary of analysis of variance tables given in the Appendix.

RESULTS

Screening Performance

Table 2 shows the mean number of target frames correctly classified for each variation in information requirements, timing procedure, and scale. Overall, the average interpreter correctly designated approximately 26 of the 37 target frames. Performance was significantly affected by requiring the interpreter to annotate non-priority objects in the imagery. The "priority only" vs "priority plus" variable was the only one affecting performance in designating target frames.

Table 2

PRIORITY-FRAME CLASSIFICATION: MEAN NUMBER CORRECT AND COMPLETENESS INDEX

Independent Variable	Level Description	N	Mean No. Correct	% Correct
Photo Scale	1:3,300	16	25.81	.70
	1:2,200	16	25.25	.68
Task	Priority Only	16	26.56	.72
	Priority Plus	16	24.81*	.67*
Work Method	Self-Paced	16	25.31	.68
	Machine-Paced	16	25.75	.70
TOTAL		32	25.53	.69

*Difference significant at the .05 level or less.

It appears that asking the interpreter to attend to targets other than those of paramount importance had a detracting effect. The man searching for priority targets alone selected almost two more target frames than did his counterpart who was searching for the same priority targets but in addition was marking non-priority targets in passing.

The finding that the "priority plus" interpreters found fewer priority frames than those working the "priority only" requirement does not tell the complete story. Of the 66 frames containing non-priority military objects, the "priority plus" interpreters detected an average of 46, or 70 percent. This result may compensate for their poorer performance in correctly identifying priority target frames, depending on the intelligence requirement.

The finding that interpreters working under the "priority only" instruction found more priority-target frames must be considered in terms of the number of frames erroneously designated as priority-target frames. Obviously, an interpreter can correctly indicate all of the priority frames by the simple expedient of classifying every one as a priority frame. Such a strategy would negate any useful purpose served by screening imagery. Table 3 shows the mean number of wrong responses made by interpreters in classifying priority frames and the corresponding accuracy scores.

Table 3

PRIORITY-FRAME CLASSIFICATION: AVERAGE NUMBER WRONG AND ACCURACY SCORE

Independent Variable	Level Description	N	Mean No. Wrong	Accuracy Score
Photo Scale	1:3,300	16	3.50	.89
	1:2,200	16	2.75	.91
Task	Priority Only	16	4.69	.86
	Priority Plus	16	1.56**	.94*
Work Method	Self-Paced	16	2.00	.93
	Machine-Paced	16	4.25	.87
TOTAL		32	3.12	.90

*Significant at the .05 level or less.
**Significant at the .01 level or less.

The "priority only" interpreter made almost three times as many erroneous frame selections as the "priority plus" interpreter. These erroneous frame classifications include the situation in which a frame containing non-priority targets was classified as a target frame as well as the situation in which a frame with no military targets imaged was

classified as a target frame. Interpreters searching exclusively for priority targets tended to classify more frames as target frames. This tendency may be responsible for the observed result that "priority only" interpreters correctly classified a greater number of exposures as target frames and in the process selected a greater number of non-priority frames as target frames. This finding is related to the observation reported by Sadacca, Castelnovo, and Ranes:

> Among interpreters furnished intelligence information about the objects for which they were to search, a larger proportion were consistently above the median in the correct identification of objects appearing in the photographs. They also reported more objects where no such objects appeared in the photographs. Many of the differences were statistically significant.[a]

In the present experiment, the information furnished would be the requirement to search exclusively for tracked vehicles.

Identification of Priority Targets

Information Requirements. The number of priority targets correctly identified was significantly affected by task requirements. Interpreters searching for and identifying only priority targets did significantly better than interpreters required also to note and identify non-priority military objects (Table 4). Neither use of the pacer nor difference in photo scale significantly affected performance.

Table 4

PRIORITY-TARGET IDENTIFICATION: AVERAGE RIGHT AND COMPLETENESS SCORE

Independent Variable	Level Description	N	Mean No. Right	Completeness Score
Photo Scale	1:3,300	16	69.81	.64
	1:2,200	16	68.25	.63
Task	Priority Only	16	72.81*	.67*
	Priority Plus	16	65.25	.60
Work Method	Self-Paced	16	72.06	.66
	Machine-Paced	16	66.00	.61
TOTAL		32	69.03	.63

*Indicates that difference is significant at the .05 level or less.

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[a] Sadacca, R., A. Castelnovo, and J. Ranes. Human factors studies in image interpretation: The impact of intelligence information furnished interpreters. BESRL Technical Research Note 117. June 1961.

Interpreters searching solely for priority objects may have been more alert to the cues and signatures which identify tracked vehicles. Interpreters working under the "priority plus" requirement may have been unable to follow to the letter their instructions not to search for the non-priority objects. They may have looked for the other objects as well. A second possible explanation rests on the difference between the total number of responses per target frame for the two interpreter groups. For the "priority only" group, target frames had from one target per frame to as many as ten targets per frame. For the "priority plus" group, there were as many as 22 targets on a target frame. A previous HLSRL study[3] indicated that the completeness with which interpreters identify the targets imaged on each target frame is inversely related to the number of targets on that frame.

Wrong Identification of Priority Targets

Interpreters instructed to identify priority objects and also to annotate non-priority objects detected incidentally made fewer wrong priority identifications than interpreters searching for and identifying only priority objects. Accuracy of performance under these two different sets of instructions was not significantly influenced. The "priority only" requirement resulted in more correct identifications of priority targets and more erroneous priority target identifications.

The frequency with which the interpreters misidentified priority targets is summarized in Table 5, together with the accuracy scores. Note that the "priority plus" interpreters had an average accuracy of 90 percent for the identification of priority targets while the "priority only" interpreter group was but 84 percent accurate (Table 5). The 6 percent difference does not quite reach the 5 percent level of confidence established for the study.

Table 5

PRIORITY-TARGET IDENTIFICATION: AVERAGE NUMBER WRONG AND ACCURACY SCORE

Independent Variable	Level Description	N	Mean No. Wrong	Accuracy Score
Photo Scale	1:3,300	16	11.12	.87
	1:2,200	16	11.00	.87
Task	Priority Only	16	14.50*	.84
	Priority Plus	16	7.62*	.90
Work Method	Self-Paced	16	7.06	.91
	Machine-Paced	16	15.06**	.82**
TOTAL		32	11.06	.87

*Indicates that difference is significant at the .05 level or less.
**Indicates that difference is significant at the .01 level or less.

[3] A study of Rapid Photointerpreter Methods. In preparation.

The result mentioned above may appear to be inconsistent with the fact that difference in number of wrong responses was statistically significant, the "priority only" interpreter group making a greater number of errors. The nature of the accuracy measure is responsible for the apparent inconsistency ($\frac{R}{R + W}$). For priority target identification, the number of right responses--and of wrong responses--was significantly larger for the "priority only" interpreters. Since the accuracy index expresses these two factors in ratio form, any differences between the two interpreter groups would be depressed.

Timing Procedures. The two work methods used in this experiment produced a significant difference in the number of identification errors made by the interpreters. The interpreter group that was mechanically paced through the imagery made over twice as many errors as did the self-paced group (15.06 to 7.06). This greater error rate of the paced group resulted in an accuracy of 82 percent while the self-paced group had an accuracy of 91 percent. It had been anticipated that by freeing the interpreter from the need to pace himself, he would be able to concentrate more completely on the search for priority objects and thus do a better job. A tentative explanation for this unexpected result is given below.

The four 50-frame film rolls contained an average of nine exposures showing priority targets. The number of targets contained in these nine exposures ranged from one to ten. Suppose the mechanically-paced group of interpreters tended to work on each of the 50 frames in a roll for the full 30 seconds allowed by the timer. The interpreter would have spent more time than was needed on the 41 frames which contained no priority targets. As he searched these non-target frames for the full 30 seconds, he might detect some object (man-made or natural feature) which resembled a priority target and make an erroneous response.

For those nine exposures that actually contained priority targets, the machine-paced interpreter might do well with those frames containing few targets but might well be unable to complete those exposures with a high density of priority targets. Consequently, he would move on to the next exposure leaving such frames with unidentified targets.

The self-paced interpreter could work through the roll in a manner more familiar to him, inspecting each successive frame and, if in his judgment a frame contained no priority targets, going on quickly to the next frame. There was no temptation to continue searching the same exposure for a fixed period of time. When he came to an exposure with a large number of priority targets, he could continue working on it until he felt that he had extracted all of the priority information present on the exposure.

Overall accuracy of identification of priority targets was a relatively high 87 percent. Fewer wrong responses and more accurate performance were obtained by having the interpreter pace himself through the mission. It is possible that greater experience with mechanical pacing might train the interpreter to use it as an aid to better performance.

Identification of Non-Priority Targets

Table 6 shows the average number of non-priority targets of each type correctly identified by the interpreters working under the "priority plus" requirement, as well as number of misidentifications and inventive errors. The average interpreter working under the "priority plus" requirement located over 100 non-priority objects while he was doing his major task of identifying tanks, APC's, and SP guns. Since there was a total of 280 non-priority objects in the imagery, mean completeness was about 37 percent. The accuracy of identification ranged from 92 percent for wheeled vehicles through 73 percent for tents to a 41 percent for military objects. The result of requiring the interpreter to annotate non-priority military objects was to reduce overall accuracy. The number of non-priority military objects invented by the average interpreter exceeded the number he correctly identified.

Table 6

MEAN NUMBER OF NON-PRIORITY TARGETS IDENTIFIED BY "PRIORITY PLUS" INTERPRETERS

Non-Priority Target Category	Number Correct	Classification of Responses: Misidentifications	Classification of Responses: Inventions	Accuracy
Wheeled Vehicles	89	1.06	6.44	.92
Tents	7.25	.06	2.62	.73
Military Objects	7.88	----	11.31	.41
TOTAL	104.13	1.12	20.37	---

The rather impressive result showing that the "priority plus" interpreter identified about 37 percent of the non-priority information while making priority target identifications has to be evaluated against the loss of about 7 percent in completeness of priority target identification. This lower completeness is further confounded by the finding that the "priority plus" interpreter made a significantly smaller number of erroneous identifications than his "priority only" counterpart.

SUMMARY OF RESULTS

Screening Performance

Information requirements imposed on interpreters significantly affected their performance in selecting target frames for further search.

1. "Priority only" interpreters selected more of the target frames than did "priority plus" interpreters.

2. However, "priority only" interpreters made more errors in selecting target frames. Overall accuracy favored the "priority plus" interpreter over the "priority only" interpreter (94% vs 86%).

3. The "priority plus" interpreter located 70 percent of the frames containing non-priority targets, and these designations were 90 percent accurate.

Target Identification

1. "Priority only" interpreters correctly identified more priority targets than did the "priority plus" interpreters.

2. "Priority only" interpreters made more than twice as many erroneous identifications of targets as did the "priority plus" interpreters. Overall accuracy, however, did not differ significantly for the two groups.

3. The "priority plus" interpreter identified over one-third of the non-priority military objects in the imagery, with an accuracy of 83 percent.

4. The self-paced interpreter made fewer erroneous identifications than the mechanically paced interpreter (overall accuracy of 91 percent vs 82 percent).

CONCLUSIONS

Differences in intelligence requirements affect both frame selection and identification of priority targets. A tradeoff situation exists. To minimize the number of errors in classifying frames as target or non-target frames, and in identifying priority targets, the interpreter should operate under the "priority plus" requirement, detecting and annotating non-priority military objects noted. Such a requirement will tend to reduce the completeness of information produced regarding priority target frames and identification of priority targets. Instructions to concentrate exclusively on target frames and priority targets seem to lead interpreters to be over-inclusive. Obviously, total completeness of target frame selection can be achieved by the interpreter who classifies every frame as a priority target frame.

Variations in photo scale within the limits established here have no effect on interpreter performance in selecting target frames and identifying priority targets. Photo scales in excess of 1:3,300 evidently cannot be expected to produce significant improvement in interpreter performance.

Since the pacing procedure adversely affected accuracy of identification, the procedure is evidently not a desirable one.

APPENDIX SUMMARIES OF ANALYSES OF VARIANCE

Table A-1

SUMMARY OF ANALYSIS OF VARIANCE -- NUMBER CORRECT AND COMPLETENESS INDEX ACROSS TREATMENT CONDITIONS
(Priority Frame Classification)

Source of Variation	Sum of Squares	df	Mean Square	F	$F_{.95}$	$F_{.99}$
Photo Scale	2.53125	1	2.53125	.3408	4.26	7.82
Task	34.03125	1	34.03125	4.5820*	"	"
Work Method	1.53125	1	1.53125	.2062	"	"
Scale x Task	.28125	1	.28125	.0379	"	"
Scale x Method	2.53125	1	2.53125	.3408	"	"
Task x Method	1.53125	1	1.53125	.2062	"	"
Scale x Task x Method	11.28125	1	11.28125	1.5189	"	"
Within Groups (e)	178.25000	24	7.42708	------		
TOTAL	231.96875	31	--------	------		

*Means significantly different, $P \leq .05$.

Table A-2

SUMMARY OF ANALYSIS OF VARIANCE -- NUMBER WRONG ACROSS TREATMENT CONDITIONS
(Priority Frame Classification)

Source of Variation	Sum of Squares	df	Mean Square	F	$F_{.95}$	$F_{.99}$
Photo Scale	4.500	1	4.500	.4509	4.26	7.82
Task	78.125	1	78.125	7.8288**	"	"
Method	40.500	1	40.500	4.0585	"	"
Scale x Task	1.125	1	1.125	.1127	"	"
Scale x Method	.500	1	.500	.0501	"	"
Task x Method	28.125	1	28.125	2.8184	"	"
Scale x Task x Method	3.125	1	3.125	.3132	"	"
Within Groups (e)	239.500	24	9.979	------	"	"
TOTAL	395.500	31	------	------		

**Means significantly different, $P \leq .01$.

Table A-3

SUMMARY OF ANALYSIS OF VARIANCE -- ACCURACY INDEX
ACROSS TREATMENT CONDITIONS
(Priority Frame Classification)

Source of Variation	Sum of Squares	df	Mean Square	F	$F_{.95}$	$F_{.99}$
Photo Scale	.00378450	1	.00378450	.5018	4.26	7.82
Task	.04945512	1	.04945512	6.5570*	"	"
Method	.02633512	1	.02633512	3.4916	"	"
Scale x Task	.00040613	1	.00040613	.0538	"	"
Scale x Method	.00066613	1	.00066613	.0883	"	"
Task x Method	.01862451	1	.01862451	2.4693	"	"
Scale x Task x Method	.00328049	1	.00328049	.4349	"	"
Within Groups (e)	.18101600	24	.00754233	------		
TOTAL	.28356800	31	---------	------		

*Means significantly different, P ≤ .05.

Table A-4

SUMMARY OF ANALYSIS OF VARIANCE -- NUMBER CORRECT AND
COMPLETENESS INDEX ACROSS TREATMENT CONDITIONS
(Priority Target Identification)

Source of Variation	Sum of Squares	df	Mean Square	F	$F_{.95}$	$F_{.99}$
Photo Scale	19.5313	1	19.5313	.1994	4.26	7.82
Task	457.5313	1	457.5313	4.6712*	"	"
Method	294.0313	1	294.0313	3.0019	"	"
Scale x Task	124.0312	1	124.0312	1.2663	"	"
Scale x Method	42.7812	1	42.7812	.4368	"	"
Task x Method	22.7812	1	22.7812	.2326	"	"
Scale x Task x Method	19.5313	1	19.5313	.1994	"	"
Within Groups (e)	2350.7500	24	97.9479	------		
TOTAL	3330.9688	31	--------	------		

*Means significantly different, P ≤ .05.

Table A-5

SUMMARY OF ANALYSIS OF VARIANCE -- NUMBER WRONG ACROSS TREATMENT CONDITIONS
(Priority Target Identification)

Source of Variation	Sum of Squares	df	Mean Square	F	$F_{.95}$	$F_{.99}$
Photo Scale	.125	1	.125	.0019	4.26	7.82
Task	378.375	1	378.375	5.8305*	"	"
Method	512.000	1	512.000	7.8896**	"	"
Scale x Task	14.875	1	14.875	.2392	"	"
Scale x Method	12.500	1	12.500	.1926	"	"
Task x Method	71.750	1	71.750	1.1056	"	"
Scale x Task x Method	.750	1	.750	.0116	"	"
Within Groups (e)	1557.500	24	64.896	------		
TOTAL	2547.875	31	-------	------		

*Means significantly different, P ≤ .05.
**Means significantly different, P ≤ .01.

Table A-6

SUMMARY OF ANALYSIS OF VARIANCE -- ACCURACY INDEX ACROSS TREATMENT CONDITIONS
(Priority Target Identification)

Source of Variation	Sum of Squares	df	Mean Square	F	$F_{.95}$	$F_{.99}$
Photo Scale	.00005513	1	.00005513	.0082	4.26	7.82
Task	.02668050	1	.02668050	[illegible]	"	"
Method	.06390313	1	.06390313	[illegible].5682**	"	"
Scale x Task	.00361250	1	.00361250	.5409	"	"
Scale x Method	.00505012	1	.00505012	.7562	"	"
Task x Method	.00414050	1	.00414050	.6200	"	"
Scale x Task x Method	.00004050	1	.00004050	.0061	"	"
Within Groups (e)	.16028850	24	.00667869	------		
TOTAL	.26377088	31	---------	------		

**Means significantly different, P ≤ .01.

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) U. S. Army Behavioral Science Research Laboratory, OCRD, Arlington, Virginia	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

EFFECTS OF INFORMATION REQUIREMENTS, TIMING PROCEDURES, AND PHOTO SCALE ON INTERPRETER PERFORMANCE

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

5. AUTHOR(S) (First name, middle initial, last name)

Thomas E. Jeffrey

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
July 1969	22	

8a. CONTRACT OR GRANT NO. b. PROJECT NO. DA R&D Proj. No. 2Q662704A721 c. Interpreter Techniques d. a-12	9a. ORIGINATOR'S REPORT NUMBER(S) Technical Research Note 211 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT

This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Office, Chief of Research and Development, DA, Wash., D. C.

13. ABSTRACT

The present publication reports on experimentation conducted by the BESRL INTERPRETER TECHNIQUES Work Unit to determine how the screening of real-time imagery is affected under differing conditions of intelligence requirements, timing procedures, and photo scale. Thirty-two graduating students ~~of the~~ Image Interpretation Course ~~at the~~ USA Intelligence School, Fort Holabird, were subjects in the experiment. Each subject screened four 50-frame rolls of photographic transparencies to select frames containing priority targets, at the same time detecting and identifying the targets. The experimental design required half the interpreters to search for and identify priority targets only, the other half to identify priority targets and while making the search also to annotate any non-priority military objects detected. Half the men worked with imagery at a 1:3,300 scale, half with imagery at 1:2,200. Half the interpreters were machine-paced through the tasks; half were self-paced under a total time limit of 25 minutes for each task (one 50-frame roll). Performance on both screening and target identification was evaluated for completeness and accuracy.

Results of the study showed: 1) Interpreters performing the "priority only" task achieved more complete selection of priority target frames and priority target identification but were less accurate in both aspects of the task than those required to make additional notations. 2) Interpreters mechanically-paced through the task were less accurate but no less complete in identifying priority targets than those working under the self-paced method. Timing procedures had no significant effect on screening performance. 3) Variations in photo scale had no effect on completeness or accuracy with which the interpreters selected target frames or identified priority targets. Within the limits established in this study, photo scales in excess of 1:3,300 evidently can-

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
*Image interpreter performance						
*Real-time imagery						
*Photo scale, variations in						
*Laboratory facilities						
Aerial imagery						
*Aerial surveillance imagery						
Interpreter performance measures						
*Interpreter techniques						
Image interpretation tasks						
*Quick-time screening						
Information requirements						
*Timing procedures						

13. ABSTRACT - Continued

not be expected to produce significant improvement of interpreter performance. 4) Interpreters working under the "priority plus" requirement annotated on the average 37 percent of the non-priority targets in the time allotted with an accuracy of 83 percent.